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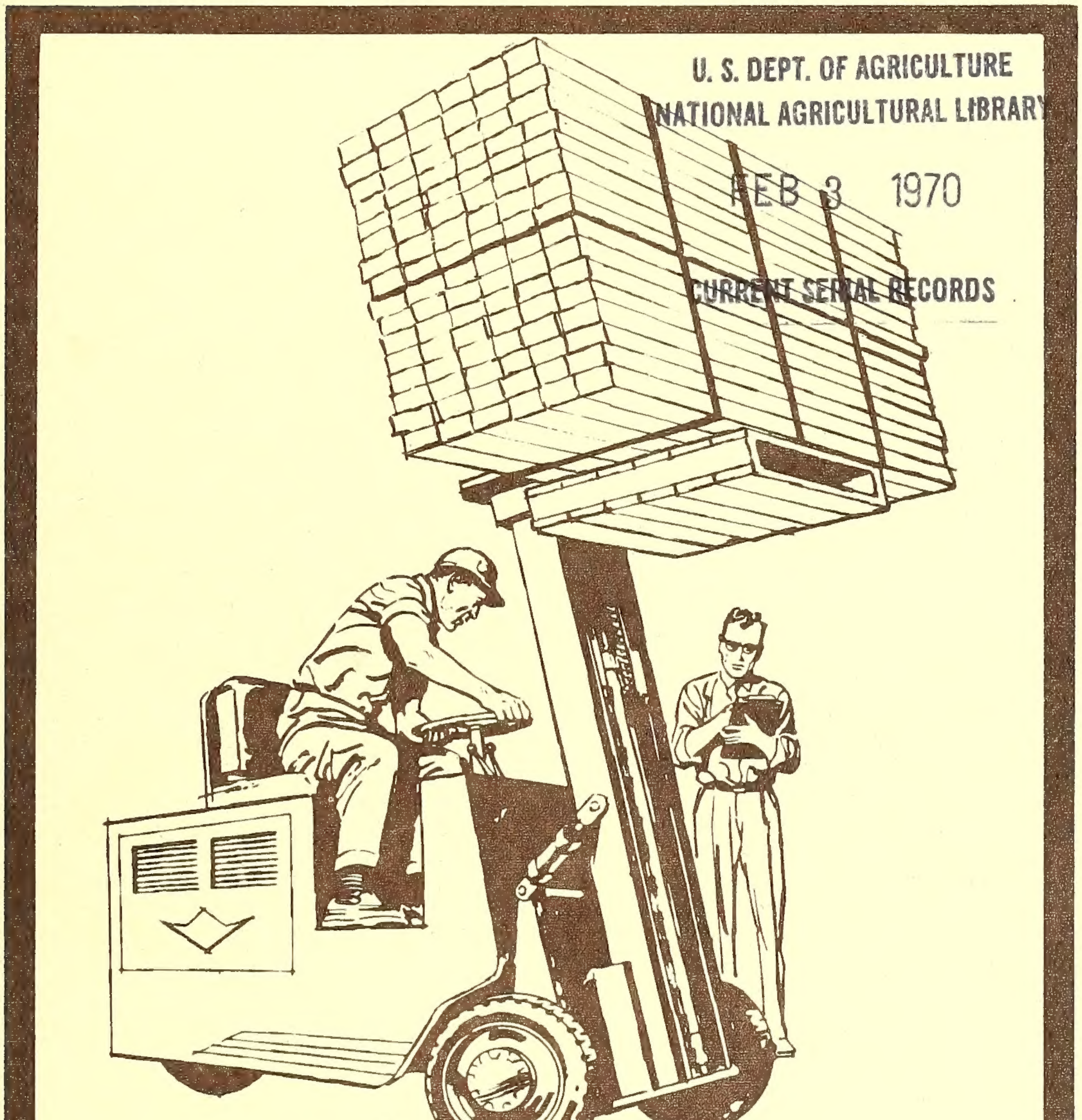
ECONOMICS OF PRODUCING AND HANDLING PACKAGED LUMBER

JOHN R. HOST



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ECONOMICS OF PRODUCING AND HANDLING PACKAGED LUMBER

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INTRODUCTION

Distribution is a major cost in manufacturing industries. Inventory handling, order assembly, and merchandising costs can amount to as much as 35 percent of retail prices in the lumber industry.

In an attempt to reduce total distribution costs, an increasing number of sawmills are packaging lumber. The first unitized flatcar of lumber was shipped in 1958. In 1968 over 40,000 unitized flatcars were shipped. Economies realized by the customer in unloading and storage have forced the rapid growth of lumber packaging. This trend will be sustained by the increasing role that distribution centers are assuming in lumber marketing.

Although it costs more for sawmills to ship packaged lumber than loose lumber, there is evidence that packaging of lumber is a profitable activity for the sawmill when such factors as improved marketability, reduced recordkeeping, and somewhat improved prices are considered.

This report presents an economic analysis of lumber packaging that may be useful to manufacturers in evaluating the process for their own operations. It is based on cost information obtained from six lumber mills in western Montana whose production ranges from 30 to 150 million board feet per year. Cost data include equipment installation and operating costs for packaging and handling lumber. Taxes, insurance, and overhead are not included because they are considered as plantwide or departmental operating expenses and are not allocated specifically to the operational procedures under study.

PACKAGING LUMBER

The general process of lumber packaging is shown in figure 1. Packages are assembled at the planer sorting chain after the material has been graded and sorted. Pieces of lumber are stacked into homogeneous units. The width of each unit is standardized at a nominal 4 feet. Height is usually 2 feet but varies. Length varies in standard 2-foot multiples from 8 to 26 feet. In this study, a unit 4 feet wide by 2 feet high by 16 feet long with a volume of 1,920 board feet is used for illustration.

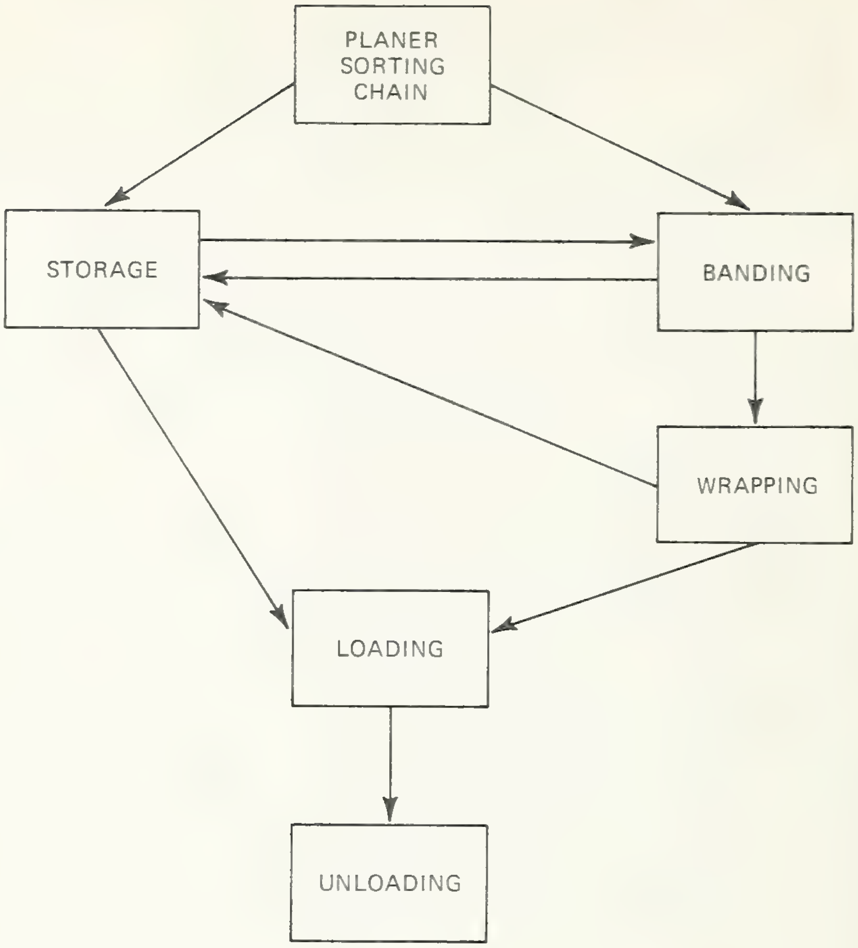
Once assembled, the unit is transported to the inventory storage area or to the banding station. The banding operation consists of squaring the unit ends (even-ending), compressing the load, applying the banding under tension, and sealing it while the unit is still under compression. If the unit is to be wrapped, a laminated kraft paper wrapping is stapled over it. The unit is then loaded onto a flatcar or put into inventory for loading out at a later time.

MECHANICAL BANDING

The banding operation starts when the forklift operator places loads onto the infeed conveyor. The banding machine operator controls the infeed conveyor, even-ends the load, operates the compression machine, applies and seals the banding, and operates the conveyor to move the banded unit to the wrapping station or to the outfeed end for pickup by the forklift (fig. 2).

The rate of production is controlled by the flow of lumber onto the infeed conveyor and off the outfeed conveyor. The forklift phase of the operation is most efficient if the packages can be doubled up at the planer chain; e.g., two 2- by 4-foot packages stacked together with a bolster between each package. The packages are separated and placed on the infeed conveyor to the banding machine separately.

Figure 1.--Banding and wrapping process flow.



By timing mechanical banding operations at the different mills through 1-hour intervals, we derived an average time of 4 minutes 12 seconds per unit. Thus 12 units per hour, or 5 minutes per unit, which is a realistic rate, will be used throughout this study. Twelve units per hour, at 1,920 board feet per unit, is a productivity rate of 11,520 board feet per man-hour for the two-man crew.

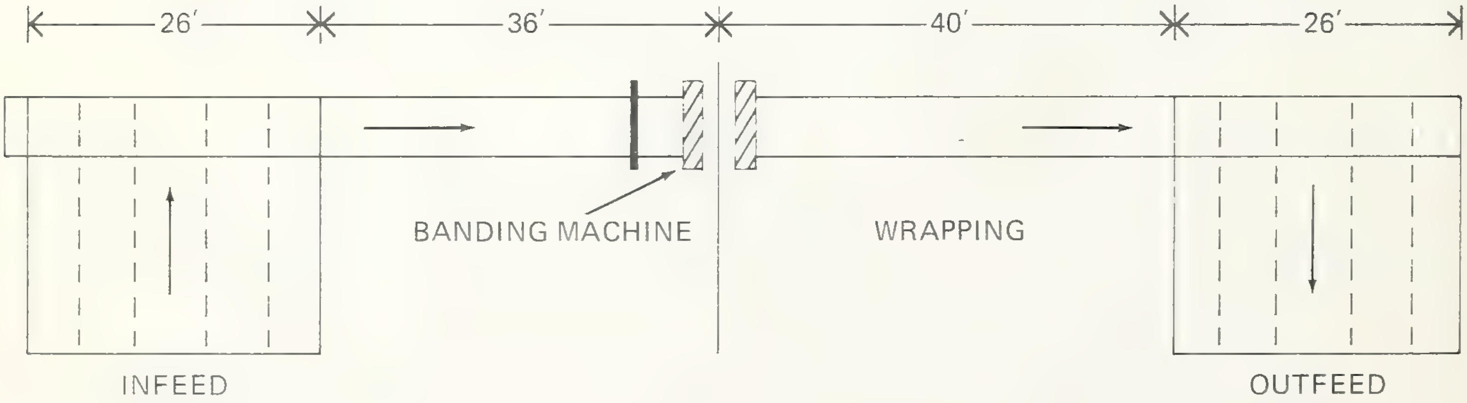


Figure 2.--Banding and wrapping layout.

The costs per M board feet for mechanical banding are:

Labor	$0.347
Amortization	.256
Materials	.165
Forklift operation	.041
	$0.809

Labor is $0.347 per M board feet.--At 4.00 per man-hour, this productivity rate represents a gross labor cost of 0.347 per M board feet. The wages assumed in this example may be applicable for some operations and unrealistic for others.

Amortization of banding machine is $0.256 per M board feet.--The average cost of a banding machine, installed, is $12,500. Assuming straight-line depreciation for a 5-year period, the annual amortization charge is $2,500. This cost includes conveyors, band and wrapping station, shed roof, and wiring. The annual banding production ranges from 7.5 to 12.0 million board feet. A median of 9.75 million board feet is used, which results in an amortization cost of $0.256 per M board feet. We recognize that the volume banded is limited by sales and not by the production capacity of the installation.

Materials cost $0.165 per M board feet.--Materials costs have been obtained from current price lists. Strapping material used is 3/4 X 0.025 inch, which costs $0.01203 per lineal foot. A 2- by 4-foot unit requires two 12.3-foot bands. These cost $0.296. Two seals are required per unit at $0.020. Thus, the total cost for materials is $0.316 per unit, or $0.165 per M board feet.

Forklift operation cost is $0.041 per M board feet.--Operating costs for a forklift are $0.950 per hour. This does not include depreciation. Generally, the forklift used in this part of the operation has been fully depreciated because it is a spare machine. At 23 M board feet per hour, this provides a cost of $0.041 per M board feet.

MECHANICAL WRAPPING

The wrapping station consists of a working space on the outfeed conveyor from the banding machine. The wrapping material is unspooled downward onto the banded unit from an overhead storage rack and stapled around the bottom of the sides and ends.

The wrapping operation requires two men. The banding machine operator can be one of these two men depending upon the production rate desired. Because there is a variable in manpower requirements that affects productivity and costs, this study shall consider both situations (Alternative 1) where the banding machine operator is not used in the wrapping operation, and (Alternative 2) where the banding machine operator is used in the wrapping operation.

Alternative 1

Where the banding machine operator is not used in the wrapping operation, the banding operation sets the production rate for wrapping. This has been substantiated by limited time studies.

Using this method to wrap lumber units, the cost per M board feet is

Labor	$0.347
Materials	0.990
Machine	--
	$1.337

Labor cost.--Productivity and labor cost are the same as for the banding operation.

Wrapping materials cost.--The cost of wrapping materials is a function of unit length and is not dependent upon production volume. A 2- by 4- by 16-foot unit requires 160 square feet of wrapping material. Using a price of $11.46 per M square feet, the wrapping material costs $0.955 per M board feet for a 16-foot unit. The cost of staples is estimated at $0.035 per M board feet. Total materials cost for wrapping is $0.990 per M board feet.

Machine cost.--The installation cost of the wrapping facility has been included in the banding machine installation. Hence, amortization charges for wrapping have been included in the banding cost. Such an allocation is permissible because the wrapping storage rack is built as part of the banding installation. In practice, the wrapping materials storage rack is a minor expense since it is usually made of scrap materials.

The cost of the forklift operation has also been charged against the banding operation. We did this because a forklift is needed for the banding operation whether or not the package is to be wrapped.

Alternative 2

Where the banding machine operator is used in the wrapping operation, overall productivity is reduced from 12 units per hour to 7 units or 13 M board feet per hour. This is because the banding operator has a break in continuity and he must move back and forth between the banding and wrapping stations.[1]

Using this method to wrap lumber units, the cost per M board feet is

Labor	$0.576
Materials	0.990
Machine	--
	$1.566

Labor cost.--The labor charge of $0.576 per M board feet is derived by using an opportunity cost analysis as follows: Using four men for the combined banding and wrapping operation (Alternative 1), the total labor cost is $0.694 per M board feet. Where three men are used (Alternative 2), the combined total labor charge is $0.923 per M board feet. The charge of $0.576 per M board feet to wrapping assumes the difference in total labor costs for the two different methods is attributed to the wrapping method that results from reduced productivity for the combined operation.

Materials cost.--The cost of wrapping materials is the same as in Alternative 1.

Machine cost.--There is no charge for machine amortization or operation as in Alternative 1.

---

[1] In this instance, three men are used instead of four for combined transport, banding, and wrapping. Productivity is reduced to 4.48 M board feet per man-hour for three men as compared to 5.76 M board feet per man-hour for four men.

HAND BANDING

The cost per M board feet of hand banding lumber packages is

Labor	$0.900
Materials	.165
Machine	.021
	$1.086

Two men require 4 hours to band 40 M board feet by hand. Parttime use of a forklift is also needed. This is estimated at 1 hour. A total of 9 man-hours for 40 M board feet or 4,444 board feet per man-hour is the productivity rate.

The labor cost is $36.00 and the forklift machine operation costs an additional $0.950. The materials cost is the same as for machine banding, $0.165 per M board feet, even though there is the likelihood that some wastage will occur. The total cost for hand banding is $1.086 per M board feet.

HAND WRAPPING

The cost of hand wrapping is

Labor	$0.800
Materials	.990
	$1.790

Two men are required to hand wrap the units. Their productivity is 5 M board feet per man-hour. The total wage charge is $0.800 per M board feet. No forklift charges are made because forklift handling has been done in the banding process. The cost of materials is the same as for machine wrapping.

COST COMPARISON

The preceding section has presented costs for banding and wrapping lumber by different methods. These costs are summarized in table 1, which shows that on a cost per M board feet, machine banding and machine wrapping using Alternative 1 is the least costly.

Table 1.--Summary of banding and wrapping costs

Item	Machine			Hand	
	Band	Band and wrap		Band	Band and wrap
		Alt. 1	Alt. 2		
Number of men	2	4	3	2.25	2.25
Productivity (MBF/man-hour)	11.5	5.8	4.5	4.4	5.0
Cost ($/MBF)					
Labor	0.347	0.694	0.923	0.900	1.700
Materials	.165	1.155	1.155	.165	1.155
Machine[1]	.297	.297	.297	.021	.021
Total	0.809	2.146	2.375	1.086	2.876

[1] Includes amortization of banding and wrapping facility and forklift operating expense where applicable.

However, a break-even analysis is required to determine the feasibility of installing machine banding and wrapping equipment because the amortization costs in table 1 are based on a fixed annual production volume of 9.75 million board feet (see page 3). If a different production volume is used, then these amortization costs will be different. Figure 3 shows that amortization costs per M board feet for the banding machine vary inversely with production volume.

Under the conditions observed in this study, the break-even point between hand and machine banding occurs at 4.7 million board feet annual production. Where annual banding production is not expected to equal 4.7 million board feet, it is not feasible to install a semiautomatic banding machine. When further consideration is given to the combined banding and wrapping process, a different situation occurs. The break-even point for annual production volume shifts to 2.6 million board feet because machine wrapping costs less than hand wrapping, as shown in figure 4. When the wrapping cost is added to its respective banding cost, the break-even point shifts to a lower annual production volume.

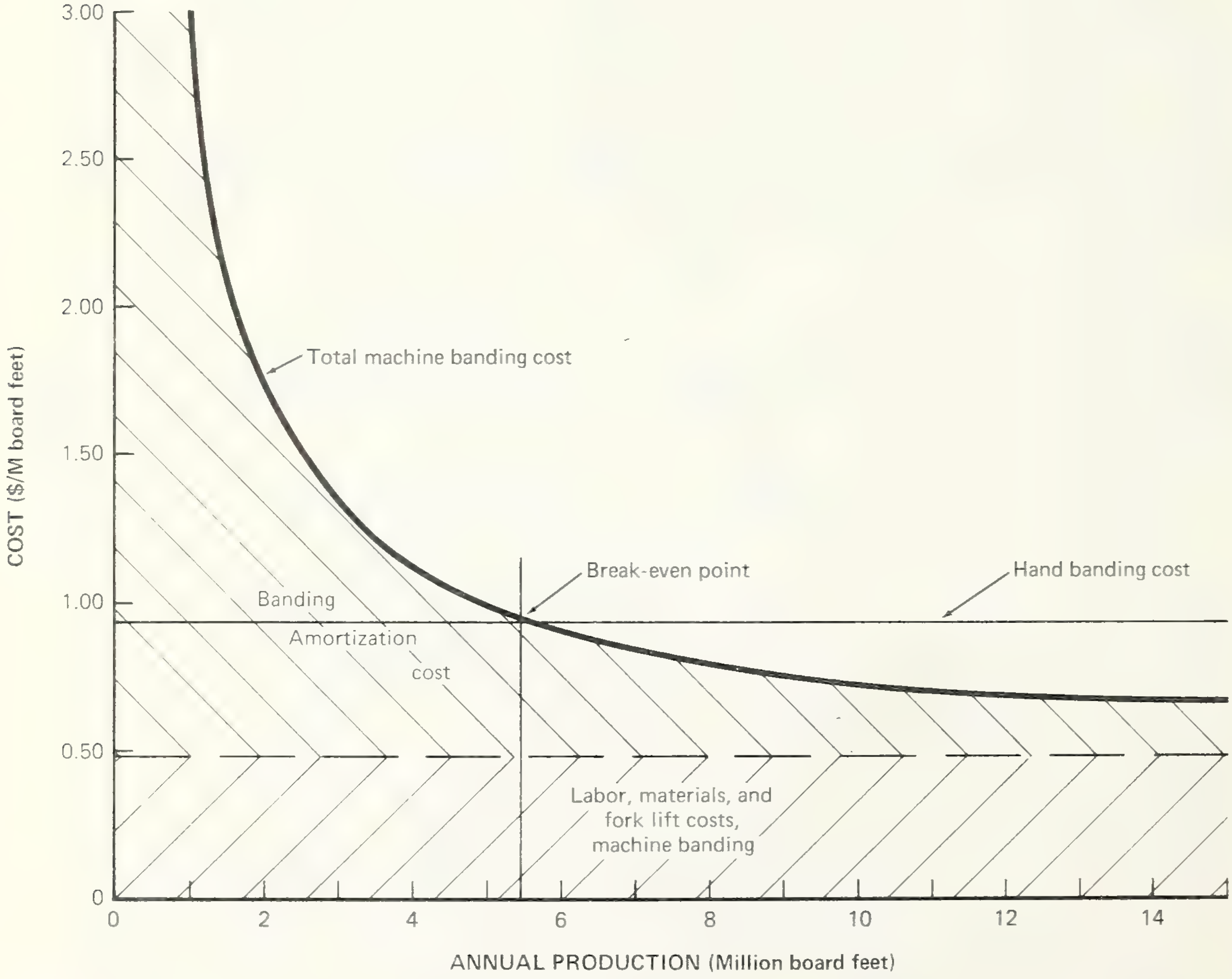


Figure 3.--Break-even comparison, hand vs. machine banding.

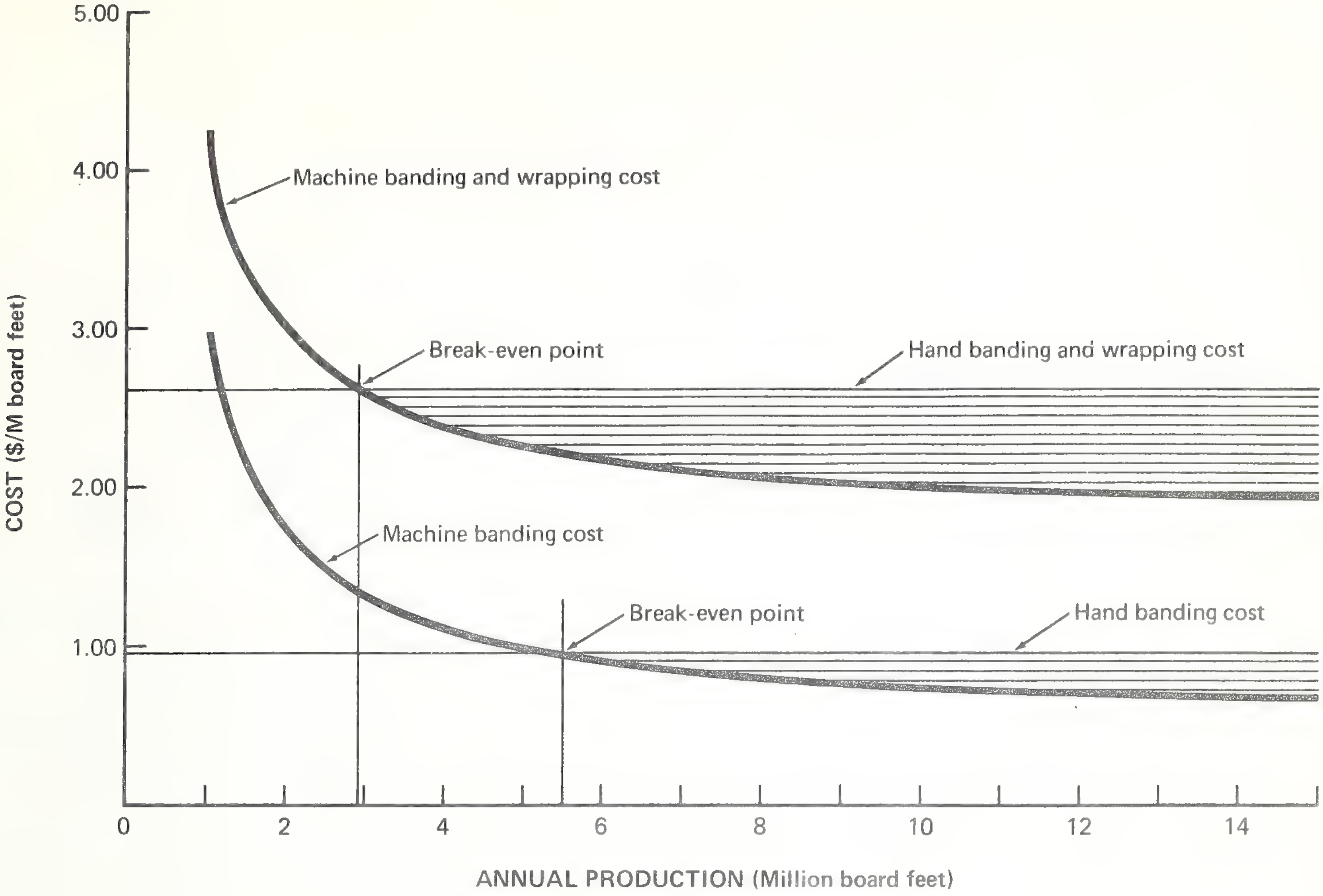


Figure 4.--Break-even comparison, hand vs. machine method.

LOADING AND UNLOADING LUMBER

Most western lumber is shipped by railroad to eastern markets. This part of the study compares the cost of loading and unloading flatcars with packaged lumber vs. loading and unloading boxcars with "loose" (unpackaged) lumber. Some packaged lumber is shipped on trucks, in wide-door boxcars, and in special "Tomco" flatcars but cost data on these are not included in this study.

LOADING FLATCARS

Loading packaged lumber onto flatcars requires planning because package placement is carefully prescribed by the American Association of Railroads (Section No. 5 of the Rules Governing the Loading of Forest Products on Open Top Cars). A diagram is used to show the placement of different length units to ensure proper overlap of unit ends to make a solid load.

A forklift with operator and one additional man are needed to load and strap the packages on the car. This can be done with little or no supervision after the crew has the experience of loading out a few cars. Assuming a 40-M-board-foot order to be loaded on the car, a two-man crew can complete the job in 2 hours. A productivity rate of 10 M board feet per man-hour is attained.

The cost per M board feet for flatcar loading of unitized lumber is

Labor	$0.40
Materials (banding)	.27
Materials (dunnage)	.44
Forklift	.05
	$1.16

Labor cost is $0.40 per M board feet.--At $4.00 per man-hour, the total labor cost is $16.00 per 40 M board feet, or $0.40 per M board feet.

Banding materials cost $0.269 per M board feet.--Strapping material amounts to 430 lineal feet per car. Layer unitizing straps are 250 lineal feet per car.[2] Load unitizing straps are estimated at 180 lineal feet per car. A study of 50 cars from a West Coast mill showed an average of 428 lineal feet was loaded on each car. Using 430 lineal feet per car, the banding cost is $10.16 per car. Seals for the banding cost $0.60 per car. Total banding materials for the 40-M-board-feet car cost $10.76 or $0.269 per M board feet.

Dunnage costs $0.44 per M board feet.--To properly brace the load requires about 500 board feet of dunnage. The AAR specifications demand the absence of strength impairing knots and decay, and recommend using rough lumber. The market value of this material is about $27.50 if a price of $55.00 per M board feet is assumed. Generally, 2,000 pounds weight is charged for this dunnage. This is about 800 pounds more than the actual weight so the net cost will amount to $17.50 if a $1.25 cwt. freight rate is used. This will then be a cost of $0.438 per M board feet.

Machine cost is $0.05 per M board feet.--A forklift is used for 2 hours to load a flatcar at $0.834 per hour; it costs $1.90 per 40 M board feet, or $0.04 per M board feet.

LOADING BOXCARS

Because of the variation in organizing loading personnel, it is difficult to determine productivity for hand loading loose lumber. Personnel used for boxcar loading can include some or all of the following: two car loaders, checker, yard pickup or tallyman, part-time forklift and carrier operators, and part-time shipping clerk. Cars loaded per two-man loading team will range from one car per day using hourly wage help up to three cars per day using contract loaders. For instance, the loading costs ranged from $1.70 to $3.03 per M board feet in this study. A large part of the difference results from contract loading vs. hourly rate loading. The incentive method is by far the cheaper. The average cost, weighted by volume shipped from each mill, is $2.30 per M board feet.

UNLOADING FLATCARS

To unload a flatcar containing packaged lumber is a relatively simple operation. Assuming the car can be unloaded from both sides and adequate preparation has been made for storing the packages, the job can be done in 45 minutes time. This requires the use of a forklift operator and a helper to remove strapping.

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[2] Layer unitizing straps are used to encircle adjacent units and bind them tightly against the load stabilizing framework. Load stabilizing straps are used to bind different layers together to tie the units into one solid load. Bearing pieces are 2 inches, or thicker, lumber nailed to the floor of the flatcar approximately crosswise.

For the sake of consistency, the same assumptions made in loading operations will be used for unloading where applicable; that is, car volume is 40 M board feet; wage cost is $4.00 per hour; and forklift operating cost is $0.950 per hour.

At 1-1/2 man-hours to unload 40 M board feet, the productivity rate is 26.7 M board feet per man-hour.

The total wage cost for unloading is $6.00 and the machine operating cost is $0.71 for a combined total of $6.71 for 40 M board feet, or $0.168 per M board feet.

UNLOADING BOXCARS

The cost of unloading a boxcar of loose lumber is difficult to determine because of the variation in orders. A highly mixed load can require two men as much as 3 days. On the other hand, a straight car shipment can be unloaded in 12 hours by two men. It will be assumed that 15 hours are needed to unload a boxcar.

At this rate, productivity is 1.33 M board feet per man-hour. Usually the yard will use pickup labor procured at the local employment agency. The wage cost for this is estimated at $2.75 per hour. Thirty man-hours at $2.75 results in a wage cost of $82.50 per 40 M board feet, or $2.062 per M board feet. The costs of supervision and of moving lumber from the car siding are not included.

COST SUMMARY AND COMPARISON

The total marketing impact of packaged lumber involves both the producer and his customer. This section summarizes the costs and benefits that accrue to the lumber mill and to the yard.

LUMBER MILL

The lumber producer is directly concerned with costs up to and including the loading of lumber. The total costs per M board feet to the producer for packaged lumber are

	Hand	Machine
Band	$1.09	$0.81
Wrap	1.79	1.34
Load	1.16	1.16
Total	$4.04	$3.31

The total cost for unpackaged lumber is $2.30, which is $1.01 less than machine packaged lumber and $1.74 less than hand packaged lumber.

By offering this service, the mill operator is providing some degree of product differentiation as compared to the mill that doesn't offer packaged lumber.

Aside from this, the mill operator is obtaining a service charge over the current selling price. In most instances, this service charge is enough to cover the additional cost.

CUSTOMER

An examination of benefits to the customer will point out why the market is paying for this service and why the impetus for this service has come from the marketplace.

There is an appreciable cost difference between unloading packaged and unpackaged lumber--$0.17 per M board feet as compared to $2.06 per M board feet.

The customer saves $1.89 per M board feet. Furthermore, it is estimated that the yard operator realizes an additional $1.30 per M board feet savings in storage and handling costs resulting from: less storage space to handle a given inventory volume through higher stacking; outside storage reducing the need for sheds; no need to band units for delivery. Hence, the yard operator accrues a total savings of around $3.20 per M board feet.

OTHER ADVANTAGES

Over and above cost considerations, there are the following benefits derived by both the producer and the customer from packaged lumber. These also have cost implications.

Speed and flexibility of loading.--Shipping personnel at the six sawmills in Montana mentioned that loading with packaged lumber permits convenient shipping of order surges when the stock is already in inventory.

Diamond Lumber Company of Tillamook, Oregon, uses four men to do the work formerly done by 14 men.[3] Efficiencies can be gained where lesser daily volumes are handled.

Breakage loss reduction.--When lumber is handled as a solid package, there is less chance for breakage or loss of individual pieces throughout the materials handling process.

Inventory procedure.--Each lumber unit has a prescribed volume for a given length. This greatly simplifies the inventory process. Also, while permitting a systematic storage method, it allows a degree of flexibility in that units can be stored where convenient with the assurance that the volume will remain constant.

A yard operator can maintain his inventory more easily because the units are marked with number of pieces, grade, and species. When a unit is opened up or loaded out, the operator is reminded how that particular item is stocked in relation to his desired volume; e.g., he is reminded as to whether or not he should order more stock.

Order assembly.--Order assembly is simplified in that pieces of lumber do not have to be tallied individually. This is particularly advantageous when sales are made using unit volumes for lot sizes.

Protection in storage --The primary demand for wrapped lumber stems from the need to preserve quality during storage through inclement weather. One study shows that the percent of studs falling out of grade during storage because of bow and crook can be as low as 4.2 percent in packaged units as compared to 12.5 percent uncovered.[4]

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[3] Forest Industries. 3 man packaging unit--1 MM a day. Portland, Oregon, July 1964.

[4] Crow's Digest. Exposure tests evaluate lumber wraps. Portland, Oregon. October 1967.

Partially wrapped piles had as much as 20.8 percent grade fallout. This study showed that the moisture content increased 0.16 percent during the same 6-month period. Thus, it appears as though proper wrapping material can help a great deal in reducing the perishability of lumber in storage.

The ability to ship banded or wrapped lumber is also a significant sales factor--particularly during late fall and through the winter--to customers who store stocks outside. It has been reported that the ability to ship wrapped lumber is the main factor in maintaining production at high levels in three plants: all felt that this also helped to obtain orders not requiring banding or wrapping.

Yard material handling.--Improved material handling has become well recognized not only for the distribution yard but for the retail yard as well. Clark Row reported practically all retail yards sampled in the Southeastern States that had forklift trucks preferred strapped shipments.[5]

Yard area reduction.--Strapped lumber packages can be stacked safely as high as a forklift can reach. This higher stacking reduces the amount of ground area required for a given inventory volume. Too, sheds are not necessary. Consequently, property taxes are lower. It is estimated that storage costs are reduced by two-thirds because of these factors.

Pricing aid.--Keeping the units intact until it is opportune to open them prevents the dealer's customers from picking through the pile to take out the best pieces. Where this picking over is done, the leftovers usually consist of poorer material for the specified grade, which is difficult to sell. Oftentimes this little dab is put into a lower grade at a reduced price or put into a "bargain pile" also at a lower price.

Delivery.--The loads can be dumped with less chance of breakage and will remain intact; thus, it is simpler for the customer to check the volume delivered. There is no scattering of pieces or individual pieces to count. Also, keeping the packages banded until time to be used in construction prevents the removal of pieces beforehand. There is less chance for pilferage at the job site. Practical Builder reports that this is an increasingly important consideration for the builder where pilferage can amount to $125 per unit being constructed.[6] Not only the dollar loss but the complicating of schedules can be costly.

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[5] Row, Clark. Changing role of retail dealers in lumber marketing. USDA Forest Serv. Res. Pap. SO-7. 1964.

[6] Practical Builder. Theft, vandalism, and pilferage. Bristol, Conn. July 1967.

LIMITATIONS

It might appear as though unit banding is the panacea for material handling. Like anything else it has its limitations or disadvantages.

Pattern stock.--Although some pattern stock has been banded, it generally has been done on a limited or experimental basis. Where edges have been run to a pattern, damage can occur from the side compression in the banding process. This occurs from the difficulty in accurately matching all the layers in the unit. Also, there is a tendency for these layers to become better alined as the load is vibrated in transit. As this alinement occurs under pressure, the pattern work tears and the pieces come together. This reduces the tension of the strapping and increases the possibility of coring in the unit.

Lot volume.--Another limitation in unit packaging becomes apparent when the customer demands lot volumes not suited for unitized loads. Not only does this prohibit unit handling but it relegates the difficult highly specified orders to hand loading. This will probably raise hand loading costs as the proportion of flatcar loaded orders increases.

Most Montana sawmills ship highly mixed stock. In fact, some of them feel this is the most important part of their sales. At times, market conditions are such that this is a very strong factor in keeping the order file at a reasonable level both volumewise and pricewise.

Claim adjustment.--It was mentioned previously that banding lumber can possibly reduce claims due to breakage. On the other hand, when claims are justified, a serious delay can occur when the unit is wrapped. The basis for claim will not be noticed until the wrapping is removed; this can be at delivery time or some months later.

Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field Research Work Units are maintained in:

Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Provo, Utah (in cooperation with Brigham Young University)

FOREST SERVICE CREED

The Forest Service of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing nation.